PROJECT SUMMARY

Firm: Creare Incorporated
Contract #: NNX11CE86P
Project Title: An Ultra Low Power Cryo-Refrigerator for Space

Purpose of the Research
On this program, Creare is developing an innovative cryocooler that requires extremely low input power. This work addresses NASA's need expressed in Topic S1.07 for an ultra-low power cryocooler that provides 300 mW of refrigeration at 35 K. The technology supports future satellites, probes and astronomical observatories utilizing superconducting bolometers, and infrared, far infrared, submillimeter and X-ray detectors. NASA missions include the Jupiter-Europa Orbiter (JEO), Wide Field Infrared Survey telescope (WFIRST), Single Aperture Far-IR (SAFIR) telescope, Space Infrared Interferometric Telescope (SPIRIT), Submillimeter Probe of the Evolution of Cosmic Structure (SPECS), and the International X-Ray Observatory (IXO). Military space applications include space-based surveillance for Operationally Responsive Space missions.

Brief Description of the Research Carried Out
During the Phase I project, we developed with NASA a set of cooling requirement consistent with a class of future space missions. We utilized the cooling requirements to perform system-level trades and develop a preliminary design of the cryocooler and cryo-radiator for a flight system. We also designed a Technology Demonstration Unit (TDU) to be tested on the Phase II program. The TDU consists of a prototypical cryocooler and cryo-radiator arranged in a brassboard configuration.

Research Findings or Results
The cryocooler designed on the Phase I project was optimized to provide 300 mW of cooling at 35 K and requires 9 W of compressor input power at 150 K. The total system mass is 6 kg including the cryocooler, electronics and cryo-radiator. The cryocooler is designed to operate at cold end temperatures of 30 to 70 K, loads of up to 3 W, and heat rejection temperatures of up to 210 K by changing only the charge pressure and turbomachine operating speeds. The area of the cryo-radiator is 0.8 m^2. The electronics utilize parts that are tolerant to 300 kRad total ionizing dose which permits usage of the cryocooler for the broadest range of missions without redesign. In addition, the cryocooler technology is extremely reliable and scalable, and produces no perceptible vibration.

Results Justify Phase II Continuation
The phase results justify continuation to the Phase II program. The overall feasibility and benefits of the cryocooler concept have been proven by analysis. On the proposed Phase II project, we will build and test a demonstration cryocooler and cryo-radiator. The Phase II testing will be structured to achieve a TRL of at least 5, and will include cryogenic performance and launch vibration testing. The performance testing will occur at cold-end temperature of 35 to 55 K and a heat rejection temperature of 150 to 210 K. The successful completion of this program will provide mission planners with an extremely high performance, lightweight, and compact cryocooler that can meet requirements for a variety of missions. The cryocooler is reliable, emits no vibration, and can be used for remote and distributed cooling.

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